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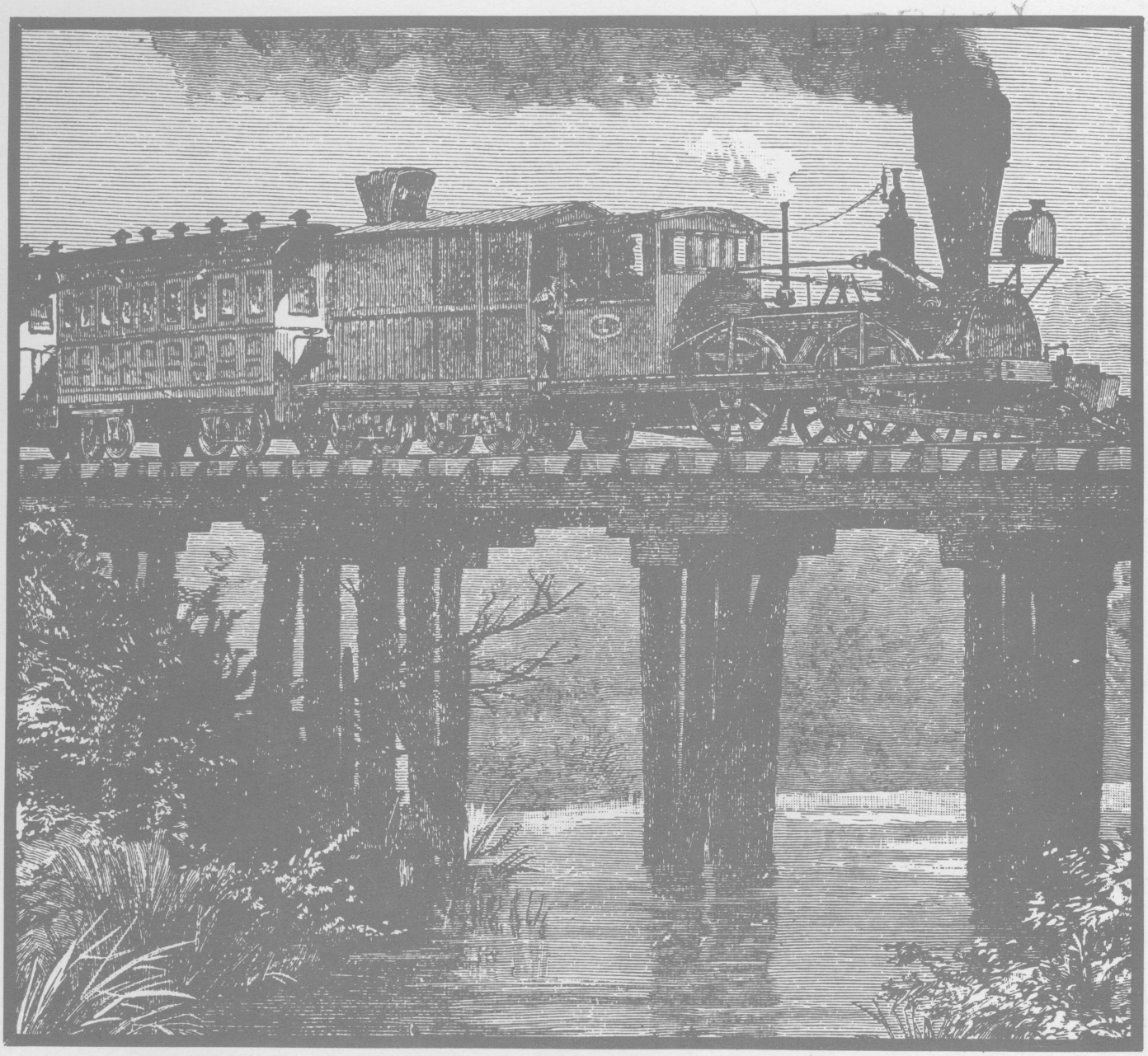
Wood Preservation and Wood Products Treatment



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PREFACE

Federal regulations establish general and categorical standards that must be met before you can legally use certain pesticides and preservatives. Your state will provide the information necessary to help you meet the general standards.

This guide for applicators and handlers of wood preservatives and wood treated products contains information you must know to meet categorical national standards. Because this guide was written to encompass the entire nation, some information important to your individual state may not be included. Your state training agency can provide you with the other pertinent study materials.

This guide discusses the prevention of wood deterioration and degradation. It includes:

- o recognition of pests and the damage they can cause,
- o methods of control, and
- o environmental and safety precautions.

It is beyond the scope of this manual to discuss technical aspects of treating processes and quality control in treating, except as they affect the safe handling and use of treating chemicals. Also, wood treatments, such as for stabilization and fire retardancy, which do not prevent or retard attack by wood-destroying organisms will not be discussed.

INTRODUCTION

Wood pesticides (preservatives) extend the life of wood products by protecting them from damage by insects, fungi, marine borers, and weather. Preservatives are applied on the basis of how and where the products will be used, the expected conditions of exposure to wood destroying agents, and the cost per year of service life. Crossties, poles, posts and other wood products that contact the ground or are exposed to the weather must be protected with preservatives to insure a reasonable service life. Other wood products, not in contact with the ground, may be treated as a precautionary measure even though they are not exposed to moisture and the weather.

Long-term tests and experience show the levels of protection needed for various products and uses. These guidelines become industry-wide standards when they are accepted by:

- o groups that use the treated products,
- o regulatory agencies, and
- o wood-preserving organizations.

Many standards and specifications have been established to control the quality of treated wood and protect the purchaser. Federal and state specifications and requirements of the American Wood Preservers Association (AWPA) are the regulations most commonly accepted.

PESTS THAT DAMAGE WOOD

Under proper use conditions, wood can give centuries of good service. But under unfavorable conditions, wood may readily be damaged and destroyed by fungi, insects, and marine borers. These pests can attack in many ways, using the wood for food or shelter. Consequently wood must be protected to insure maximum service life when used under conditions favorable to these pests (Fig. 1).

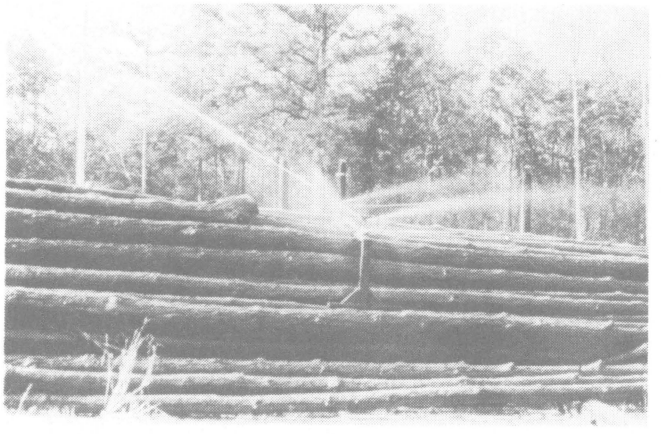

Figure 1
Sprinklers protect logs against mildew and rot by keeping wood saturated (photo courtesy of Dr. Terry Amburgey).

Wood-Inhabition Fungi

Wood decay, mold and most sapwood stains, are caused by fungi. These fungi feed on living or dead wood. The many fungi that develop on or in wood can be divided into two major groups, depending on the damage they cause:

- o wood-destroying fungi (decay fungi),
- o wood-staining fungi (sapstaining fungi, mold fungi).

Both of these fungi groups produce spores (analogous to tiny seeds), which are distributed by wind and water. The spores can infect moist wood during storage, processing and use.

All fungi that grow on wood have certain basic requirements:

- o Favorable temperature-usually ranging between 50 degrees and 90 degrees F. The optimum is about 70 degrees to 85 degrees F. Wood is basically safe from decay at temperatures below 35 degrees F and above 100 degrees F.

- o Adequate moisture-Fungi will not attack dry wood (i.e. wood with a moisture content of 19 percent or less) 1/ Decay fungi require a wood moisture content (M.C.) of about 30 percent (the generally accepted **fiber saturation point** of wood)

  Thus, air dried wood, usually with a M.C. not exceeding 19 percent and kiln dried wood with a M.C. of 15 percent or less can usually be considered safe from fungal damage.

- o Adequate oxygen - Fungi cannot live in water-saturated wood (Fig. 1).

- o Food source (wood itself).

1/ National Design Specifications

Wood Destroying Fungi

Both the sapwood and heartwood of most tree species are susceptible to decay. Decay fungi may grow in the interior of the wood or appear on wood surfaces as fan-shaped patches of fine, threadlike, cottony growths or as rootlike shapes (Fig. 2, 3).

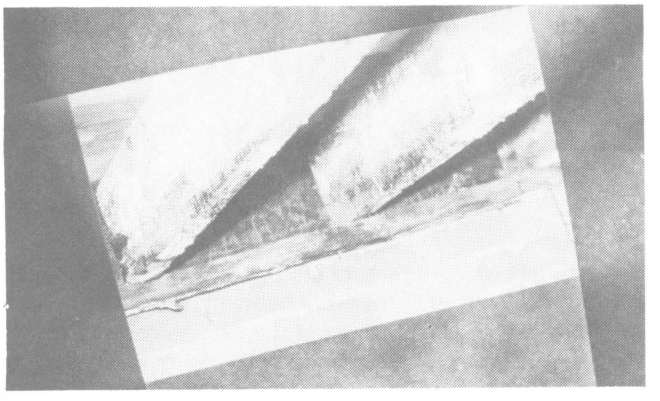

Figure 2
Mycelial fungus growth of wood-rooting fungus.

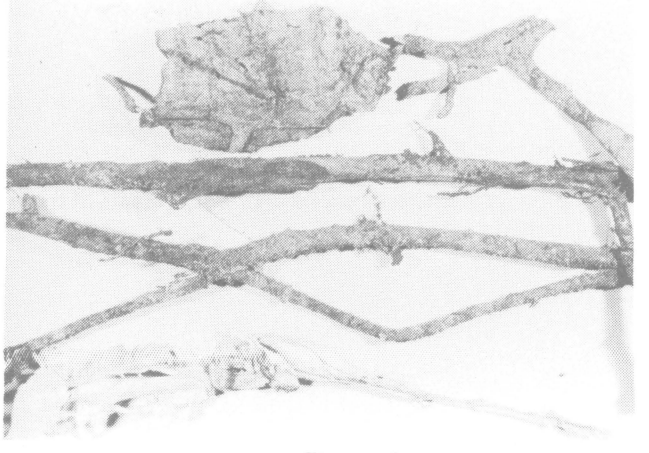

Figure 3
Root-like structures of a brown rot fungus.

The color of these growths may range from white through light brown, bright yellow, and dark brown. The spore-producing bodies may be mushrooms, shelf-like brackets, or structures with a flattened, crustlike appearance. Fine, threadlike fungal strands grow throughout the wood and digest parts of it as food. In time, the strength of the wood is destroyed.

Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is drier than

the fungi's requirements. However, decay can resume when the temperature and moisture content become favorable again.

Wood decay fungi can be grouped into three major categories:

- o brown rot,
- o white rot, and
- o soft rot.

Brown rot - Fungi which cause brown rot are able to break down the cellulose component of wood for food, leaving a brown residue of lignin. Brown-rotted wood can be greatly weakened even before decay can be seen. The final stage of wood decay by the brown rots can be identified by:

- o the dark brown color of the wood,
- o excessive shrinkage,
- o cross-grain cracking, and
- o the ease with which the dry wood substance can be crushed to powder.

Brown-rot fungi are probably the most important cause of decay of softwood species used in above-ground construction in the United States (Fig. 3). Brown-rot, when dry, is sometimes called 'dry rot'. This is a poor term, because wood must have moisture and will not decay when it is dry.

A few fungi that can decay relatively dry wood have water-conducting strands that are able to carry water from damp soil to wood in lumber piles or buildings. These fungi can decay wood that otherwise would be too dry for decay to occur. They sometimes are called the 'dry rot fungi' or 'water-conducting fungi'.

White Rot - White-rot fungi, which break down both lignin and cellulose, have a bleaching effect which may make the damaged wood appear whiter than normal.

Soft Rot - Soft rot fungi usually attack green (water-saturated) wood (high M.C.), causing a gradual softening from the surface inward that resembles brown rot.

The Wood-Staining Fungi

Sapstaining fungi - These fungi penetrate and discolor sapwood, particularly of the softwood species. Typical sapstain, unlike staining by mold fungi, cannot be removed by brushing or planing. Sapstain fungi may become established in the sapwood of standing trees, sawlogs, lumber and timbers soon after they are cut and before they can be adequately dried. Strength of the wood is little affected, but the wood may not be fit for uses where appearance is important (such as siding, trim, furniture and exterior millwork that is to be clear-finished).

Southern pine beetles often carry blue stain fungi into trees. This can cause the wood of infected trees to be stained before they are cut.

Mold fungi - These fungi first become noticeable as green, yellow, brown or black fuzzy or powdery surface growths on softwoods. Freshly cut or seasoned stock, piled during warm, humid weather, may be noticeably discolored in 5 to 6 days or less. As with sapstains, molds do not reduce wood strength, however, they can increase the capacity of wood to absorb moisture, thereby opening the door to attack by decay fungi.

Chemical Stains

Chemical stains may resemble blue or brown stains, but are not caused by fungi. These stains result from chemical changes in the wood during processing or seasoning. The most important chemical stains are the **brown stains** that can downgrade lumber for some uses. They usually can be prevented by rapid drying at relatively low temperatures during kiln drying.

Insects

Several kinds of insects attack living trees, logs, lumber and finished wood products for food and/or shelter. These pests include various termites, ants, and beetles.

Termites

Termites use wood for food and shelter and are the most destructive of all wood insects (Fig. 4).

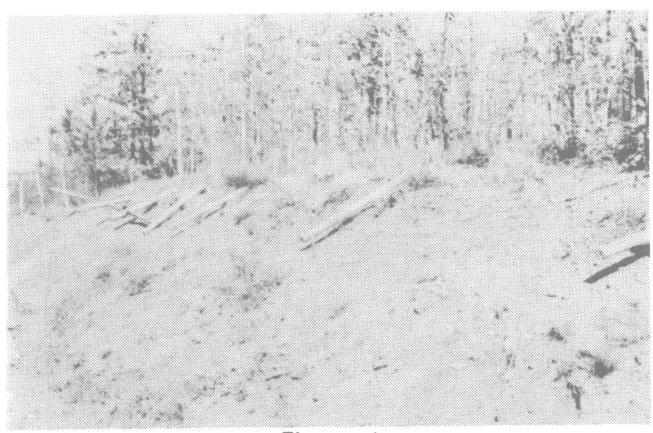

Figure 4
Inadequately treated fence posts destroyed at ground line by termites.

Ants cannot use wood for food, but they are often confused with termites because the two look somewhat similar. However, there are several distinct differences in their physical appearance. Ants have 'elbowed' antennae; termites do not. Ants have narrow waists whereas termites' bodies are broad. Ants' wings have few veins and the hind wings are smaller than the front wings. Both pairs of termite wings are similar in shape and size and have very small veins (Fig. 5).

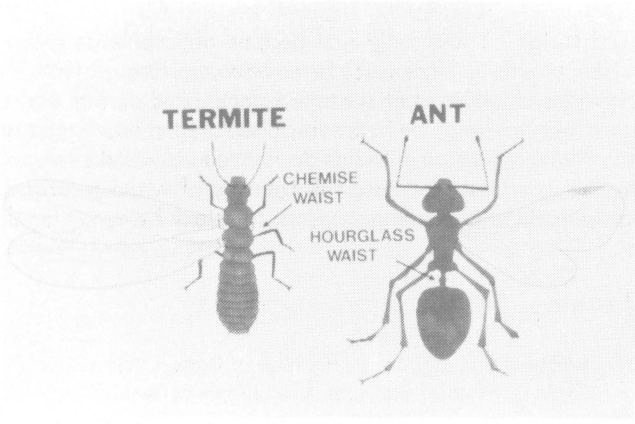

Figure 5
Differences between termite and ant.

Termites are divided into three major groups.

- o Subterranean or ground-inhabiting termites,
- o Drywood Termites,
- o Dampwood Termites.

Subterranean Termites- These termites attack wood products in buildings and other wood products throughout most of continental United States, but most damage occurs in the warm, southern coastal regions along the Atlantic Ocean and Gulf of Mexico.

At certain seasons of the year, winged males and females are produced by the termite colony. They swarm, mate, lose their wings, and attempt to begin a new colony in the soil (Fig. 6).

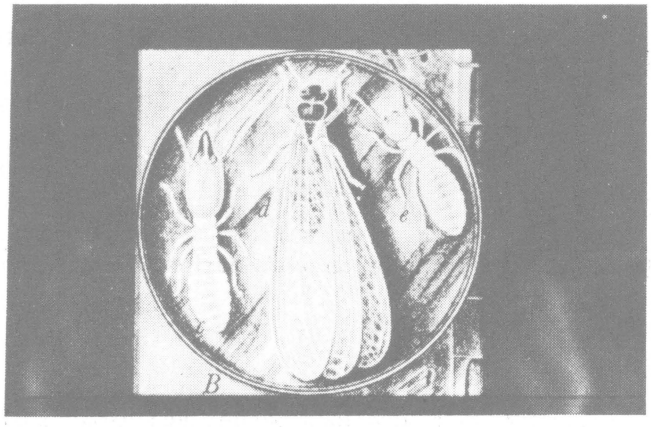

Figure 6
Subterranean termite - soldier, winged reproductive, and worker (1952 USDA Yearbook of Agriculture).

Termites build tunnels through earth and around obstructions to get to a source of food (either sound or decaying wood). They also require a constant source of moisture - usually obtained from the soil.

The presence of subterranean termites may be noted by:

- o the swarming of winged, ant-like insects and the discarded wings observed after swarming
- o earthen shelter tubes built over masonry or other foundations to a source of wood
- o the presence of white workers when termite shelter tubes are broken open
- o the hollowed-out condition of badly infested wood products

Drywood Termites- Drywood termites are found naturally only in Hawaii, Puerto Rico, and in a narrow strip of land extending from southern California and Texas to Florida and along the Atlantic coast to Virginia.

After swarming, drywood termites enter cracks and crevices in dry, sound wood. In excavating their galleries, they occasionally discharge oval-shaped fecal pellets through temporary openings in the wood surface. The ability of the drywood termite to live in dry wood without direct contact with the soil increases its menace. However, it reproduces slowly and does not destroy wood as quickly as the subterranean termite.

Dampwood Termites- Dampwood termites are a serious pest along the Pacific Coast. They do not require contact with the soil, but do need wood with a high moisture content.

Ants

Carpenter ants may be black or red. They usually live in stumps, trees, or logs, but often damage poles or structural timbers set in the ground. Elevated portions of buildings, such as windowsills and porch columns, are susceptible to damage. Carpenter ants use wood for shelter not for food (Fig. 7).

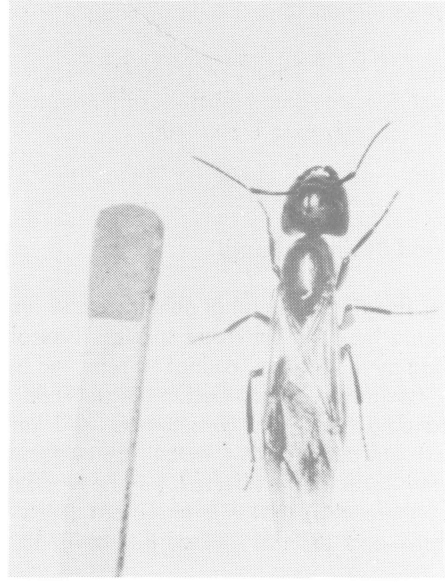

Figure 7

Winged carpenter ant by book match.

They usually prefer wood that is naturally soft or has been softened by decay. The galleries are large, smooth and, unlike those of termites, are free of refuse and powdery wood. Mounds of sawdust indicate their presence.

Beetles

Powder Post or Lyctus Beetles- Powder post beetles attack both freshly cut and seasoned hardwoods and softwoods. They attack the sapwood of ash, hickory, oak, and other hardwoods.

Adults lay eggs in the wood pores (Fig. 8).

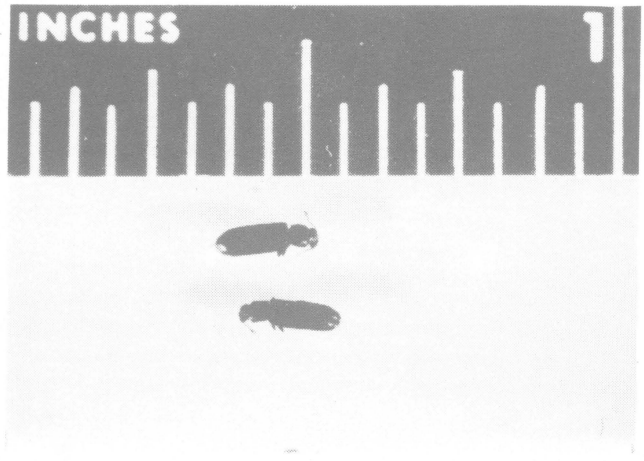

Figure 8

Adult powder post beetle.

The larvae burrow through the wood, making tunnels from 1/16- to 1/12-inch in diameter, packed with a fine powder. After a larval period (from a few months to a year, or longer - depending on the species) and a much shorter pupal stage, newly formed adults chew holes through the wood surface and emerge to lay eggs for another brood. Signs of damage by powder post beetles are:

- o small round 1/16' holes in the surface of the wood made by emerging adults, and
- o fine powder that falls from the wood.

Anobiid beetles- may attack softwoods in damp and poorly ventilated spaces beneath buildings. Eliminating the source of moisture will cause the colony to slowly die out.

Roundheaded Borers- A longhorn beetle, commonly known as the old house borer, damages seasoned pine timbers (Fig. 9). The larvae bore through the wood. Over many years their tunneling can weaken structural timbers, framing members, and other wooden parts of buildings. Contrary to its name, the old house borer most often infests new buildings. It is found in the Eastern and Gulf Coast States.

Larvae reduce sapwood to a powdery or sawdust-like consistency. They may take several years to complete their development. While working in the wood, they make a ticking or gnawing sound. When mature, the adult beetle makes an

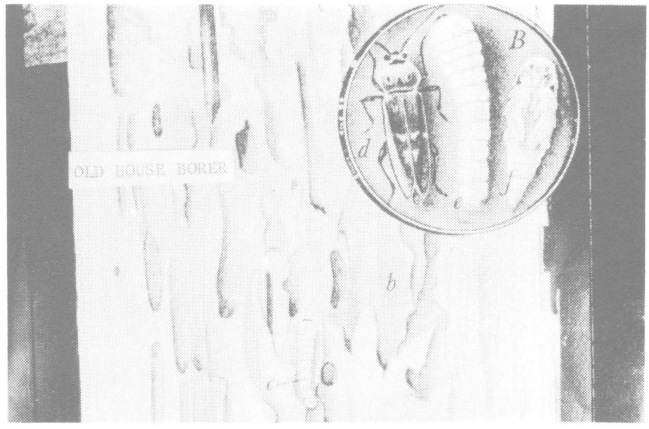

Figure 9

Old house borer - adult, larva, and pupa (1952 USDA Yearbook of Agriculture).

oval emergence hole about 1/4 inch in diameter in the surface of wood.

Flatheaded Borers- Flathead borers infest live trees as well as recently felled and dead, standing softwood trees. They can cause considerable damage in rustic structures and some manufactured products by mining into sapwood and heartwood.

Typical damage consists of rather shallow, long, winding galleries that are packed with fine powder. Adults are often called metallic wood-boring beetles because of their color. They are about 3/4 inch long, with wing covers usually rough, like bark.

Marine Borers

Extensive damage is done to submerged portions of marine pilings, wharf timbers, and wooden boats by a group of animal organisms known collectively as marine borers. In the United States they are especially active in the warm waters of the Pacific, Gulf, and South Atlantic coasts. Untreated timbers can be destroyed in less than a year.

The major marine borers are the **shipworm** and **pholad** mollusks (related to the clams and oysters), and the **crustacean borers** (related to the crabs and lobsters).

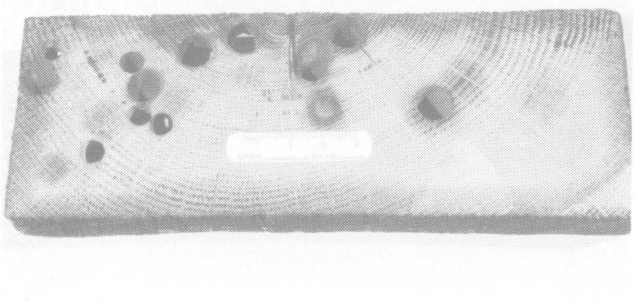

Figure 10
Shipworm damage.

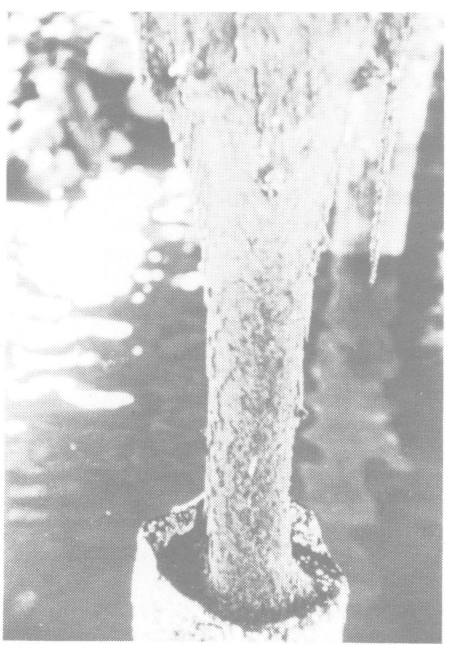

Figure 11
Crustacean borer damage - severely weakened marine piling.

CONTROL OF PESTS THAT DAMAGE WOOD

If wood is to be used where it will be subject to pest attack, it must be protected. This protection can be achieved by:

- o control of moisture content
- o use of a wood that is naturally resistant to the pests
- o chemical treatment

In addition, mechanical barriers (such as metal termite shields and caps on pilings, poles and posts) are sometimes used, but are usually ineffective.

Moisture Control

The moisture content of living trees and the wood products obtained from them may range from about 30 percent to more than 200 percent. Much of this moisture must be removed for most uses. 'Green' lumber usually is dried:

- o to prevent stain and decay,
- o to reduce damage by insects,
- o to reduce uncontrolled dimensional change (shrinkage),
- o to reduce weight and increase strength, and
- o to prepare the wood for treatment with chemical preservatives.

The amount of water in wood (its moisture content) is usually expressed as a percentage of its ovendry weight. The moisture is measured by:

- o the ovendrying method-a small sample of wood is weighed, dried, and reweighed until it has reached a constant weight when subjected to temperatures of 212 degrees-220 degrees F.
- o the electrical method - use of a moisture meter that measures moisture by electrical resistance.

Timber or logs stored for a long time before processing can be protected from fungi and insects by:

- o keeping the logs submerged in a pond of water
- o keeping them under constant water spray

The water reduces the oxygen content and temperatures necessary for growth of fungi.

Seasoning or Drying

The moisture content of wood is reduced by:
- o air drying in a yard, shed or pre-drier (Fig. 12),
- o drying in a kiln, retort or by radio frequency

The most efficient and most widely used system is kiln drying (Fig. 13).

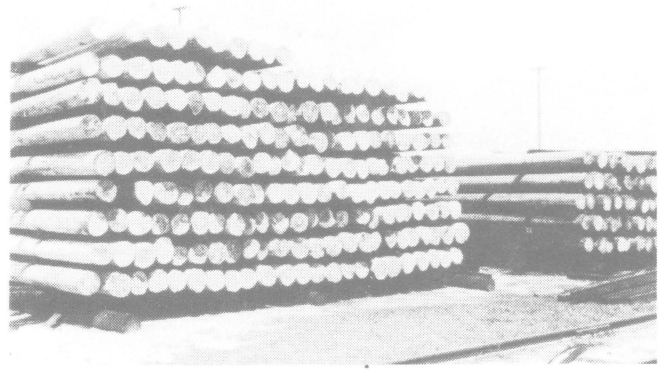

Figure 12
Air drying in yard prior to treatment.

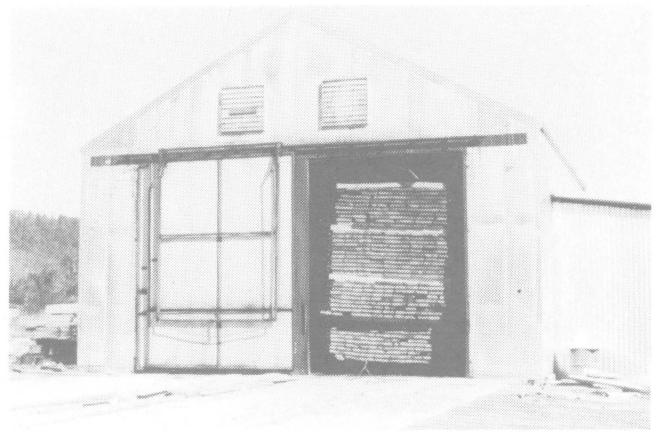

Figure 13
Kiln drying.

It offers better control of air movement, temperature and drying rate than air drying. Although kiln drying is more expensive in terms of capital investment and energy cost it is much faster and provides more uniform and better quality drying. Unless lumber is properly stacked and protected, air drying may result in surface checking, end cracking, warping, staining and discoloration due to weathering.

Even after being well-seasoned, wood may again reach a moisture level favorable to pests if exposed to rain or prolonged high humidity and favorable temperatures.

Storaging and Handling

To avoid pest induced degrading of lumber during storage or handling, you should:

- o Convert logs into lumber as quickly as possible.
- o Dry the lumber as quickly as practical, even after pressure treatment with a preservative chemical, to prevent degrading (surface checking, and end cracking).

- Locate air-drying yards and sheds on well-drained sites with good air circulation, and keep the yards free of weeds.
- Practice good sanitation by removing debris or rotted wood which serves as a source of fungal infection and insects.
- Inspect stored wood products often. Termites, for example, may invade untreated stacked lumber if it remains undisturbed for long periods.
- Avoid rough handling of treated wood. Chipping, gouging, or splitting can expose unprotected interior wood and allow attack by decay fungi (Fig. 14).

Figure 14
Storage yard free of weeds.

Use of Naturally Resistant Wood

The sapwood of all native tree species and the heartwood of most species have a low natural resistance to decay. However, the heartwood of some species is quite resistant. Examples are the heartwood of old- growth bald cypress (limited supply), cedar, redwood, and post oak. **They are resistant but definitely not immune to attack by decay fungi and insects**. Black locust and resinous southern pine heartwood, called 'fatwood' or 'lighterwood' is also highly resistant to decay.

Unfortunately, some naturally resistant woods are expensive or unavailable in commercial quantities (i.e. chestnut) or in dimensions needed. Because of high costs for labor and materials, the variable and undependable resistance of these species should preclude their use for most high hazard construction applications.

Chemical Control

The proper application of chemical preservatives can protect wood from decay and stain fungi, insects and marine borers, thus prolonging the service life of wood for many years.

The effectiveness of preservative treatment depends on the chemical formulation selected, method of application, proportion of sapwood to heartwood, moisture content of the wood, amount of preservative retained, depth of chemical penetration and distribution. Sapwood of most commercial species accepts preservatives much better than heartwood, and softwood species are generally more receptive to impregnation than the hardwoods. Preservative treatment by pressure is usually required for most wood products used for structural and other applications exposed to high risk of attack by fungi, insects or marine borers.

Type of Preservatives

Wood preservatives fall into three broad categories:

- creosote and creosote solutions,
- oilborne preservatives, and
- waterborne preservatives.

Creosote and Creosote Solutions- Creosote, an oily by-product of making coke from bituminous coal, is widely used as a preservative for such products as railroad ties, large timbers, fence posts, poles, and pilings (Fig. 15).

Figure 15
Creosoted railroad ties.

Advantages:
- toxic to wood-destroying fungi, insects, and some marine borers,
- low volatility,
- insolubility in water,
- ease of handling and application.

Disadvantages:
- dark color,
- strong odor,
- oily, unpaintable surface,
- tendency to bleed or exude from the wood surface,
- should not be used in homes or other living areas because of toxic fumes.

Oilborne Preservatives- These chemicals are generally insoluble in water. They are usually dissolved in petroleum or other organic solvents in order to penetrate wood. Research developments have recently made available oilborne preser-

vatives formulated as water- in-oil emulsions or dispersions in water.

Advantages:

- o toxic to fungi, insects and mold,
- o can be dissolved in oils having a wide range in viscosity, vapor pressure and color,
- o low solubility,
- o can be glued depending on the diluent or carrier, and
- o ease of handling and use.

Disadvantages:

- o can leave an oily, unpaintable surface, depending on the carrier,
- o for some applications provides somewhat less physical protection to wood than creosote,
- o should not be used in homes or other living areas because of toxic fumes, and
- o it's toxic and irritating to plants, animals and humans.

Pentachlorophenol (penta) is the most commonly used oilborne preservative. It is used to commercially treat poles, lumber, crossarms, timbers, and fence posts.

Penta is also used by do-it-yourselfers to treat a variety of wood products by nonpressure methods such as brushing, spraying and dipping. These superficial treatments can also temporarily preserve wood during shipping, storage or in low hazard situations such as millwork and siding. Penta is not recommended for marine installations, use inside buildings or use close to plants (Fig. 16).

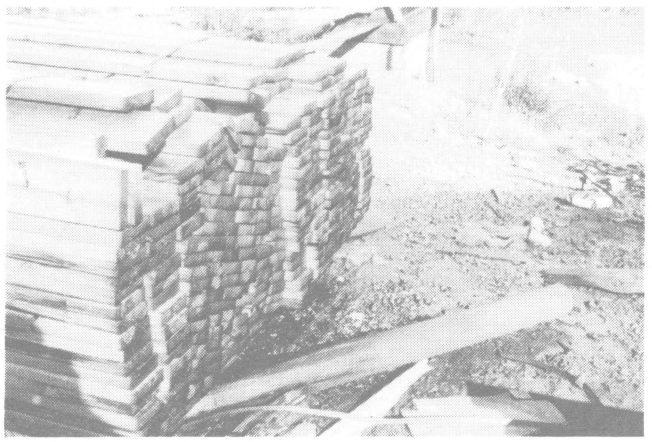

Figure 16
Penta treated lumber.

Waterborne Preservatives- This class of preservatives includes various metallic salts and other compounds. The principal compounds used are combinations of copper, chromium, arsenic and fluoride. Waterborne preservatives have gained increasingly wider usage for lumber, plywood, fence posts, poles, pilings and timbers.

Advantages:

- o treatment presents no hazard from fire or explosion.
- o the wood surface is left clean, paintable and free of objectionable odors.
- o safe for interior use and treatment of playground equipment.
- o leach resistant.

Disadvantages:

- o unless re-dried after treatment, the wood is subject to warping and checking,
- o does not protect the wood from excessive weathering (Fig. 17).

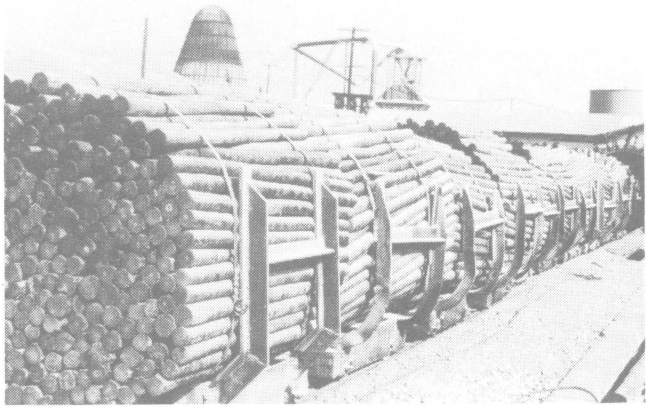

Figure 17
Waterborne preservative treated posts.

Wood treated with copper-8-quinolinolate has been approved for food contact uses such as for boxes, crates, pallets, truck decking and related uses involving the harvesting, storage and transportation of food.

APPLICATION OF WOOD PRESERVATIVES

Preparation of Wood for Treatment

For most of the commercial wood treatments in common use, wood must be prepared in some way before a preservative is applied. This preparation may include peeling, drying, conditioning, incising, cutting, and framing.

Peeling

The bark and cambium must be completely removed before treatment. This allows the preservative to penetrate into the wood. Bark obstructs penetration, resulting in exposed untreated wood (Fig. 18).

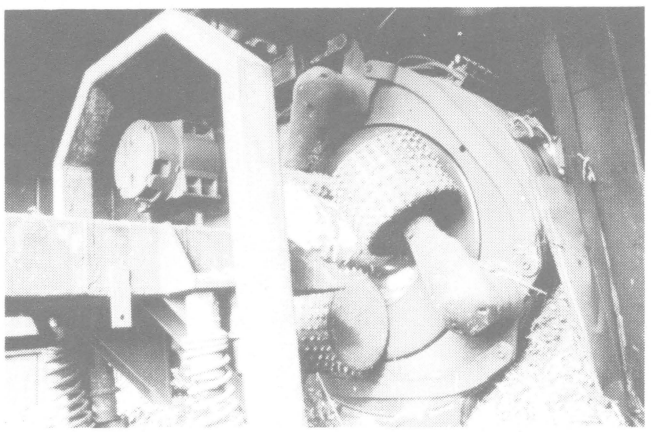

Figure 18
Debarking a log.

Drying

In most treating methods, a high moisture content prevents or slows the entrance of the preservative into the wood cells. Drying the wood allows better penetration of the preservative, reduces product weight and shrinkage with its potential for warping and checking after treatment.

Kiln drying is one method for accelerating drying under controlled drying conditions.

Conditioning

Operators of pressure treating plants can use several other methods besides conventional drying to condition wood for treatment. In the steaming and vacuum process, green wood is steamed in a treating cylinder or retort for several hours and then subjected to a vacuum. The vacuum reduces the boiling point of the water in the wood and speeds its removal. Then the evaporated water can be replaced by the preservative, applied under pressure.

Another method of conditioning green wood is boiling under vacuum (Boulton method). The wood is placed in a treating cylinder and submerged in hot oil. Then a vacuum is applied, removing water from the wood. With this method, wood can be conditioned at a lower temperature. Consequently, it can be used to avoid damage to a wood species (such as Douglas fir) which is sensitive to the higher temperatures of the steaming and vacuum process.

A third method of conditioning is known as vapor drying. In this process green wood is exposed to hot vapors of an organic compound, such as xylene, which gradually vaporizes and removes the water.

Incising

Incising consists of making a series of narrow holes or slits in the wood about 1/2- to 3/4-inch deep. This allows preservatives to better penetrate impregnation-resistant wood species (such as Douglas fir). Incising makes possible a more uniform penetration to at least the depth of holes.

Cutting and Framing

Cutting, shaping or drilling wood after treatment can expose untreated wood. This exposure can be avoided by cutting, shaping or boring the wood for its intended use before the preservative treatment. The treated wood then can be used without further machining (Fig. 19).

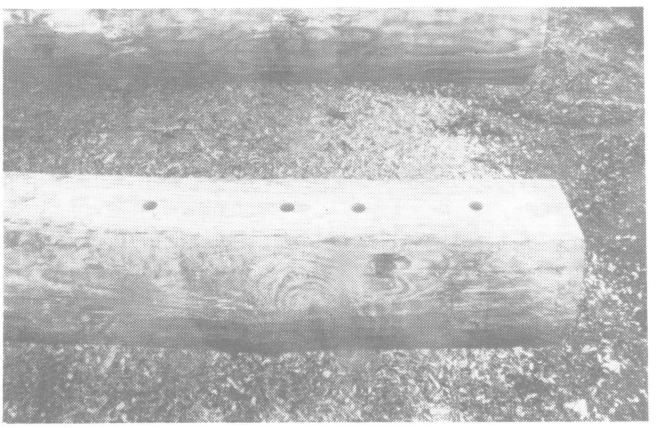

Figure 19
Boring prior to treatment.

Methods of Applying Wood Preservatives

There have been almost as many methods for applying wood preservatives as there are different preservatives. Only the ones in current use will be discussed. The treating method selected depends greatly on the ultimate use of the product. The two major types of treatment are pressure and nonpressure methods. Many variations of these methods are described in the standards and specifications of the American Wood Preservers Association (AWPA), the Federal Government, and other organizations.

Pressure Processes

We might expect wood to treat easily because of its porous structure, but wood is surprisingly resistant to deep penetration by preservatives. The basic principle of pressure processes involves the placement of wood materials in an airtight, steel cylinder or retort and immersing it in a preservative under pressure to force the preservative into the wood (Fig. 20).

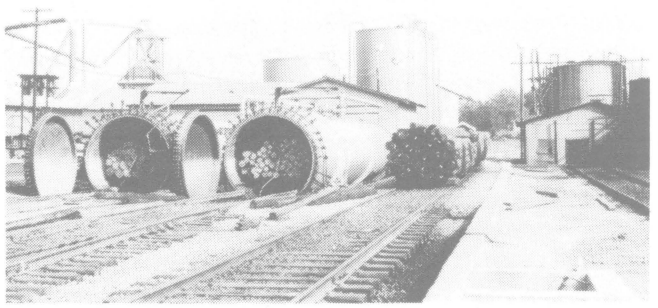

Figure 20
Pressure cylinder.

Impregnation of preservatives by pressure is the most common method used in the commercial treatment of wood. It has several advantages:

- o it gives a deeper and more uniform penetration,
- o it allows better control over retention,
- o wood can be preconditioned in the chamber,
- o it is quicker and more reliable than non-pressure methods, and
- o it can comply with code regulations and engineered specifications.

There are two basic variations of the pressure treatment method: the full-cell process and the empty-cell process.

With either method, it is important to closely follow established standards on:

- o preparation of the wood product to be treated,
- o amount and duration of vacuum and of pressure,
- o solution temperature (when critical),
- o treating time,
- o type of preservative, and
- o concentration of the preservative.

Non-pressure Processes

Non-pressure methods may be satisfactory where deep penetration, high levels of retention and precise treatment are not required. The effectiveness of non-pressure methods depends on the kind of wood, its moisture content, method and duration of treatment and the preservative used.

There are many methods of applying preservatives to wood without the use of pressure. Some of the more widely-used methods are described:

Brushing, Spraying and Pouring Treatments- With these methods, creosotes-oil-borne preservatives, or water-borne salts are applied to the surfaces of the wood product to be treated. The wood should be thoroughly air dried before treatment and, if oil-borne preservatives are used the wood should be warm enough to avoid congealing the oil. Penetration by dipping or spraying is superficial, resulting mostly from capillary action, so only limited protection is afforded. The preservative should be flooded over the wood surfaces and be allowed to soak in. Two applications are desirable, but the second should not be applied until the first has dried and soaked into the wood. Brushing, spraying or pouring treatments probably are most widely used for protecting areas of previously treated wood that have been cut or machined, thereby exposing untreated surfaces or joints.

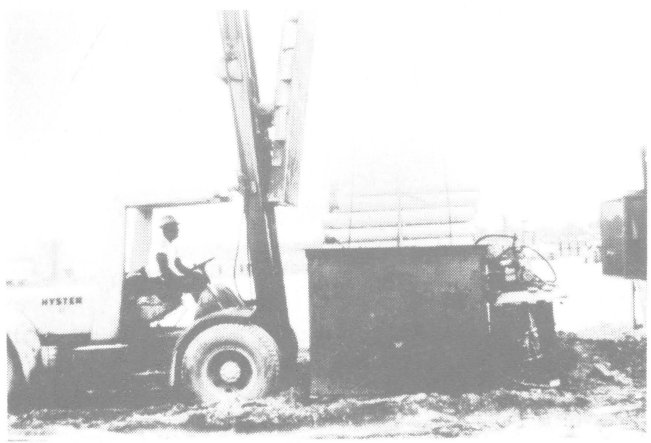

Figure 21
Dipping for treatment.

Dipping- Treatment by dipping consists of immersing wood in a preservative solution for several seconds to several minutes. As with brushing- type treatments, the wood should first be well dried before treatment. Although dipping is better than brushing for penetration of preservatives into the checks and cracks of wood surfaces, and may add 2 to 4 years of protection over untreated wood, dipping is unsatisfactory for uses subject to abrasion. Probably the principal use of dipping is for window frames employing an immersion of 3 minutes. (Fig. 21).

Cold Soaking- Cold soaking is commonly used for treating round, fence posts and sawn timbers using pentachlorophenol or other viscous, **oil-borne** preservatives. The process involves the soaking of dried wood for 2-7 days in a vat containing the unheated liquid oil preservative. Cold soaking has been popular for farm use because of its simplicity and low cost (Fig. 22).

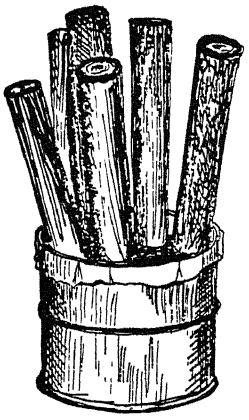

Figure 22

Cold soaking or steeping.

Steeping- The steeping process employs a **water-borne** salt preservative solution to either dry or green wood. It consists of submerging the wood in a tankful of the solution at atmospheric temperature for several days or weeks (heating the solution would speed-upenetration). Absorption is rapid the first 3 days then continues at a decreasing rate almost indefinitely. When treating flat-sawn, wood products space should be provided between and around each piece of wood to permit complete exposure to the preservative material.

Hot and Cold Bath (Thermal Process)- The hot and cold bath or thermal process, also called the boiling-and-cooling or open-tank treating method, is suitable with oil-based and water-borne preservatives. When used properly, the method provides a reasonably effective substitute for pressure impregnation. The process is quite simple involving the use of one or two tanks. With two tanks the wood product first is immersed into a hot solution usually of the preservative, itself, or even boiling water, followed by its immersion into a tank of cold solution (Fig. 23).

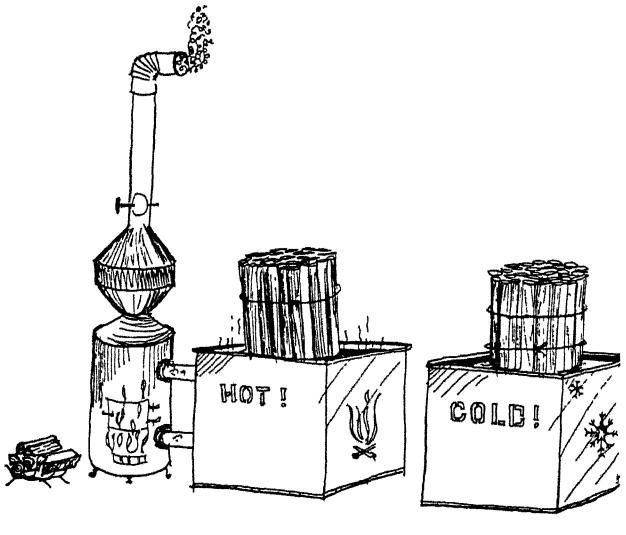

Figure 23
Hot and cold bath.

Most preservative absorption and penetration takes place during the cold bath. When one tank is used, heating can be discontinued, allowing the wood and preservative to cool together.

Double Diffusion- Treatment by double diffusion is a two-stage dispersion of a preservative liquid into a piece of wood. An example of the process would be to first soak a green wood product, such as a post, in a solution of copper sulfate. When a sufficient amount of the chemical has diffused into the wood, it is then immersed in a second solution consisting of sodium arsenate and sodium chromate. The purpose of double diffusion is to convert very leachable, chemical salt solutions into fixed and stable preservatives within the wood.

Vacuum Process- In the vacuum process wood products are enclosed in an airtight container from which air is removed with a vacuum pump. The container then is filled with the preservative without additional pressure and without the air re-entering. The partial removal of air from the wood, by the vacuum, followed by addition of the preservative creates a slight pressure that drives the preservative into the wood. Vacuum treatment works well with penta and easily treatable woods and products like pine, window stock.

Preservative Pads or Bandages (Treatment on Site) - There are several variations of employing this treating concept: The preservative can be applied to the surfaces of the wood, can be injected into the wood or placed into holes drilled in the wood. The preservative used can be water-borne, solvent in oil or have a consistency of grease or mayonnaise.

This method is most often used to extend the life of standing poles that had previously been treated. Since treated poles are costly, consideration must be given to replacement costs, including treatment and installation, so a 5-year increase of service life would be a very worthwhile expenditure for preservative bandage treatment.

The major task of this treating process involves removal of soil from around the pole for a depth of about 18'. This part of the pole, below ground, and the part 12' above ground is the portion most vulnerable to decay and failure. All decayed wood and soil must be removed from the pole and the preservative should be applied thoroughly to the 'cleaned' portion of the pole. This treated area should then be wrapped with a heavy duty, water resistant paper or plastic film to confine the preservative to the pole.

Sapstain (Blue Stain) Prevention- Sapstain fungi do not decay their wood host, but they degrade lumber and other wood products and lower their value. Also, sapstain fungi often precede the decay fungi because conditions favorable for attack (high temperatures and humidity) are comparable for both types of fungi.

To protect green logs, poles and other round timbers, they should be processed soon after trees are felled. If they cannot be processed promptly, the timbers should be stored submerged in water or be subjected to a continuous spray of water. When these storage methods are not feasible, protection for several months can be afforded by application of a chemical spray containing a solution of benzene hexachloride and penta in fuel oil. The entire log and especially the ends must be

sprayed thoroughly soon after a tree is felled and bucked into logs.

With regard to lumber, during prolonged periods of warm, humid weather, the prospect of staining is almost inevitable in the sapwood of untreated, susceptible species such as the pines. Since stain can develop within 4 days, under favorable conditions, chemical treatment should be applied within 24 hours after sawing green logs. Sapstain preventing solutions are available under various trade names. Protection is usually provided at the sawmill by carrying the rough sawn, green lumber on the moving 'green chain' through a tank or through the treating solution. Stain treatments do not provide long-lasting protection. Consequently, after treatment, the lumber should be stickered and properly piled for rapid air-seasoning or kiln drying.

Factors Influencing the Effectiveness of Wood Preservatives

Federal Specifications TT-W-571 and the Standards of the American Wood Preservers Association (AWPA) are commonly used by the wood preserving industry and consumers of treated wood to regulate the wood preserving process and better insure its suitability for specific applications.

Penetration

The effectiveness of a wood preservative depends on several treatment factors, one of which is the depth of its penetration into the wood. Inadequate chemical penetration may allow fungi and insects to enter through checks or cracks in the thin shell of treated wood in order to reach the inner, unprotected wood.

The depth of penetration attainable by a wood preservative depends on the wood species, the proportion of sapwood to heartwood and the treatment process used. The sapwood of most species is fairly easily penetrated when well-dried and pressure treated. The treatment of heartwood is much more variable than sapwood. For instance, the heartwood of southern yellow pine and maple can be impregnated to depths of about one-fourth to one-half inch. Red oak can be completely penetrated, whereas it is almost impossible to penetrate the heartwood of white oak or western red cedar with commercial pressure treating processes.

Retention of Preservatives

Even with the proper preservative penetration, good protection cannot be achieved unless enough preservative stays in the wood. Retention is measured in **pounds per cubic foot** (lbs./cu. ft.) of wood. For example, the minimum retention of creosote for lumber used in coastal (salt) waters is 25 lbs./cu. ft. (AWPA C-2), while for similar wood products in fresh water only 10 lbs. of creosote/ cu. ft. is required. By contrast, water soluble salt preservatives only require retentions of 0.2 lbs. to 2.25 lbs./cu. ft. depending on use.

Selection and Conditioning of Wood

Federal Specifications TT-W0571 and AWPA Standards identify the wood species that are acceptable for treatment for various uses. Selection of a species or grade of wood for a particular use should be based on the applicable grading rules. These rules take into consideration such properties of the wood as knot sizes, warp, splits and grain which may limit some uses.

The drying and conditioning of wood before treatment significantly influences the effectiveness of the treatment, as discussed earlier in this chapter.

Handling After Treatment

Treated wood should be handled with sufficient care to avoid cutting or breaking through the treated area and exposing the underlying untreated wood (Fig. 24).

Figure 24
Moving treated lumber.

Throwing, dropping or gouging treated wood may cause damage that expose untreated wood. When damaged in this way, the exposed wood should be retreated. This is usually done by in-place treatment (brushing). When treated wood is machined, thereby exposing untreated wood, such as by boring or cutting the ends of piles after driving) a prescribed preservative should be applied to the exposed wood (AWPA M4 Standards).

End Use

Treated wood that is used for a purpose for which it was not intended may result in an unsatisfactory service life (Fig. 25).

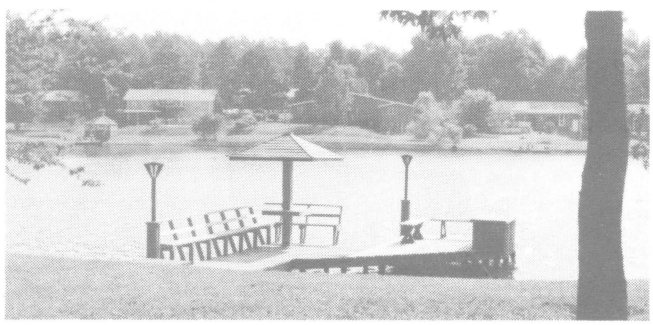

Figure 25
Service life depends on proper treatment and end use.

For example, pilings treated to meet specifications for fresh water should not be used in marine waters.

Some end-uses will place a greater physical stress on treated wood than other uses and will result in a shorter service live. The cost of replacement for some end-uses may justify periodic retreatment of wood, on site, to prolong its service life.

PROTECTING HUMAN HEALTH

Introduction

Most chemicals used to protect wood from insects and decay are toxic in order to be effective. The goal is to select chemicals and methods that will control the pests without harming the applicator, the user, the public, or pets. It is the responsibility of the management of any wood preserving operation to ensure that the proper handling procedures, protective clothing and any necessary equipment (such as respirators) are supplied to workers in conformance with label instructions to protect their health.

The EPA-approved labeling on pesticide products, including wood preservatives, is the **primary** source of information on application methods, precautionary measures for workers, emergency first aid for high level exposures, and disposal instructions for used pesticide materials and containers. The label has the force of law, and it is the provisions of the label which are enforced by state regulatory agencies. Thus, the label for each formulated product used at a wood treatment operation should be readily available, and all responsible personnel should be familiar with their contents.

Hazards to Applicators

All handlers of wood preservatives need to know about potential hazards and necessary precautions. Since risks are directly related to degree of exposure, most of the risks associated with wood preservatives comes from their application and the volatilization that occurs soon after treatment, rather than from use of the treated wood itself. The decision by EPA to classify three of the major wood preservatives, creosote, inorganic arsenicals, and pentachlorophenol, for restricted use was based on the potential human risk from chronic toxicity (exposure over a long period of time). Applicators as a group are the people most likely to be exposed over long periods, and consequently need to take precautions as a normal and routine part of working with wood preservatives.

Exposure to wood preservatives can occur in a variety of ways: during handling and mixing the chemicals, entering pressure- treatment cylinders, working around spray or dip operations, handling freshly treated wood, cleaning/servicing equipment or disposing of wastes. Closed systems for handling the chemicals and mechanically handling treated wood help to reduce potential exposure, but do not eliminate the possibility of some routine or accidental exposure for workers.

Wood preservatives, like other pesticides, can enter the body in three ways (Fig. 26).

- o oral
- o dermal
- o respiratory

Since many wood preservatives have a strong odor and taste, it is unlikely a person would swallow a dangerous amount. The more likely forms of exposure are dermal (skin) contact, or inhalation of vapors, dust or particles, particularly if protective clothing and other precautions are not observed (Fig. 27).

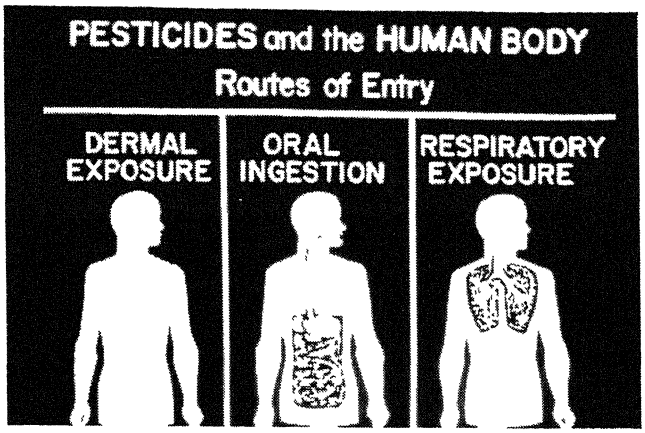

Figure 26

Routes of entry.

Figure 27
Washing after exposure.

Toxicity

The decision by the Environmental Protection Agency to classify for restricted use the three principal wood treatment preservatives [1]/ is based on evidence that:

1. creosote causes cancer in laboratory animals and has been associated with skin cancer in some workers occupationally exposed to creosote;

2. creosote and inorganic arsenicals also cause **mutagenic** effects (gene defects) in bacteria and laboratory animals;

3. arsenic has been shown in epidemiology studies to be associated with cancer in humans who either drank water con-

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1/ ...except for the brush on treatment of the inorganic ardenicals where use will be for commercial construction purposes only and not for household use.

taminated with arsenic or who breathed air containing arsenic.

4. pentachlorophenol has produced defects to the offspring of laboratory animals; and

5. a dioxin contaminate (HxCDD) in pentachlorophenol has been shown to cause cancer in laboratory animals.

Because of the potential hazard of these preservatives, there are new EPA label requirements for their handling and end use. In addition to the potential hazards of chronic toxicity, a single or short term exposure can cause the following acute health effects:

Creosote:

- o can cause skin irritation; vapors and fumes are irritating to the eyes and respiratory tract; and prolonged and repeated exposure may lead to dermatitis.

Pentachlorophenol:

- o Irritating to eyes, skin and respiratory tract.
- o Ingestion of penta solutions, inhalation of concentrated vapors or excessive skin contact may lead to fever, headache, weakness, dizziness, nausea, and profuse sweating. In extreme cases, coordination loss and convulsion may occur: high levels of exposure can be fatal.
- o Prolonged exposure can lead to an acne-like skin condition or other skin disorders, and may cause damage to the liver, kidneys or nervous system.

Inorganic arsenicals:

- o exposure to high concentrations of arsenical compounds can cause nausea, headache, diarrhea and abdominal pain (if material was swallowed); extreme symptoms can progress to dizziness, muscle spasms, delirium and convulsion.
- o prolonged exposure can produce chronic, persistent symptoms of headache, abdominal distress, salivation, low-grade fever, and upper respiratory irritation.
- o long term effects can include liver damage, loss of hair and fingernails, anemia and skin disorders.

First Aid

Since accidents do happen, first aid information on the chemical(s) in use must be readily available. The product label gives basic first aid directions, as do Material Safety Data sheets supplied by chemical manufacturers. The following general steps are applicable for accidental exposure to wood preservatives.

- o In cases of skin contact, first remove contaminated clothing that's in contact with the skin, immediately wash the affected areas with mild soap and water. Don't irritate the skin with vigorous scrubbing. Later, if you notice inflammed skin, redness or itching in the affected area, consult a doctor.
- o In cases of eye contact, immediately flush the eyes with running water. Lift the upper and lower eyelids for complete irrigation and continue for fifteen minutes, then see a doctor.
- o If accidental inhalation has occurred, move the victim to fresh air and apply artificial respiration as needed. Get medical help immediately.

If chemical preservative has been swallowed, call medical help immediately:

* If creosote or penta was swallowed, first give one or two glasses of water, induce vomiting, then administer two tablespoons of 'USP Drug Grade' activated charcoal inwater.

* If an arsenical chemical has been swallowed, drink large quantities of water, or milk if available. Get professional medical help immediately.

- o Never attempt to give anything by mouth to an unconscious person.
- o Never induce vomiting in an unconscious person.

Protecting the Applicator[1/]

General

- o Good work habits are reflected in the general precautions included on all wood preservative labels. These basic, common-sense hygiene rules can significantly reduce risks of chronic exposure to wood preservative chemicals. For example:
- o Don't eat, drink or smoke in the work area - a worker's hands can transmit residues to whatever they touch.
- o Wash hands often, especially **before** using the restroom, smoking or eating.
- o Remove gloves to handle paper work, phones or equipment which others may handle with unprotected hands.
- o At commercial treatment plants, protective clothing must be left at the plant. If work clothes must be laundered at home, wash them separately from other laundry.
- o **Protective clothing** requirements will be specified on the label. These will include use of **impermable gloves** for applying the preservatives and in all situations where dermal (skin) contact is expected (e.g., handling freshly

1/ Adapted in part from: Federal Register, Friday, Jan. 10, 1986, Part III, Environmental Protecttion Agency, pp. 1334-1348, Vol. 51, No. 7.

treated wood and manually opening pressure treatment cylinders). In certain situations such as spraying the chemicals and working around pressure treatment equipment, additional clothing may be required. Such clothing may include overalls, jackets, boots, respirators (properly fitting and maintained, approved by MSHA/NIOSH 1/ goggles and head covering.

o Individuals who enter pressure treatment cylinders and other related equipment that is contaminated with the wood treatment solution (such as cylinders that are in operation or are not free of the solution) must wear protective clothing, including overalls, jacket, gloves, and boots, impervious to the wood treatment solution, and a respirator.

Special Precautions

Pentachlorophenol:

o For prilled, powdered or flaked formulations of pentachlorophenol: Until August 31, 1987, a closed emptying and mixing system must be used or protective clothing, including respirator, gloves, long-sleeved shirt and long pants or disposable coveralls, must be worn when emptying and mixing prilled, powdered or flaked formulations of pentachlorophenol. After September 1, 1987 a closed system must be used when emptying and mixing such formulations of pentachlorophenol.

o For the spray method of application, spray apparatus must (1) be operated so as to minimize overspray (i.e., no visible mist) and (2) be free of leaks in the system. Should there be a visible mist, spray applicators in the zone in which mist is visible must wear respirators and protective clothing (including overalls, jacket, gloves, boots and head covering) impervious to the wood treatment formulation and goggles.

o Exposure to pentachlorophenol during pregnancy should be avoided.

Arsenicals:

o All exposed arsenic treatment plant workers will be required to wear a respirator if the level of ambient arsenic is unknown or exceeds a Permissible Exposure Limit (PEL) of 10 micrograms per cubic meter of air (ug/m3) average over an 8 hour work day. This PEL is the same as the standard required by the Occupational Safety and Health Administration.

o Processes used to apply inorganic arsenical formulations shall leave no visible surface deposits on the wood. Small isolated or infrequent spots of chemical on otherwise clean wood shall be allowed.

Limitations on Use

Recent EPA regulations on wood preservatives include some limitations on treating wood intended for certain uses, and on certain uses of treated wood. Be sure that the label allows you to use the preservatives for the specific use you intend. Not all of these limitations are the responsibility of commercial treaters, but these limitations should be known. The following is a summary of wood preservation use limitations.

o **Pentachlorophenol and creosote cannot be applied indoors.**

o Pentachlorophenol- or creosote-treated wood must not be used where there may be contamination of feed, food, drinking or irrigation water.

o **Pentachlorophenol** cannot be applied **to wood intended for use in interiors**, except for millwork (with outdoor surfaces) and support structures which are in contact with the soil in barns, stables, and similar sites and which are subject to decay or insect infestation. **A sealer must be applied in those instances** 2/.

o **Creosote** cannot be applied to wood intended to be used in interiors except for those support structures which are in contact with the soil in barns, stables, and similar sites and which are subject to decay or insect infestation. Two coats of **a sealer must be applied** 2/.

o The application of pentachlorophenol to logs for construction **of log homes is prohibited.**

o If creosote or pentachlorophenol is applied to wood intended to be used where it will be exposed to body contact, sealants must be applied 2/.

Material Safety Data Sheet (MSDS)

Material Safety Data Sheets are available from the manufacturers and distributors of the wood preservatives they sell. These sheets contain information on such topics as toxicity and first aid, personal protection and controls, storage and handling precautions, spill-leak disposal practices, transportation, physical data, and reactivity data.

You should have a MSDS on file for each different formulation that you use. Some states may have 'right-to-know' laws that will require you to do this.

Voluntary Consumer Awareness Program

In order to apprise the consumer of the proper uses of treated wood and the proper precautionary measures to take when using such wood, the treated wood industry has developed a voluntary Consumer Awareness Program (CAP). The treated wood industry is committed to the implementation of the CAP and the education of the consuming public.

The treated wood industry will develop a model Consumer Information Sheet (CIS) containing use site precautions and safe working practices for each of the three types of preser-

1/ (MSHA) Mine Safety and Health Administration (NIOSH) National Institute for Occupational Safety and Health.

2/ ...except for the brush on treatment of the inorganic arsenicals where use will be for commercial construction purposes only and not for household use.

vatives. The CIS will serve as the main vehicle for conveying information about treated wood to consumers. The focus of the CAP will be on ensuring the dissemination of the CIS at the time of sale or delivery to end users.

The individual wood treater's CIS will, at a minimum, contain the language agreed to by AWPI, SAWP, NFPA, and EPA on the model CIS, to the extent it applies to the wood preserver's product.

Wood treaters will be free to add other information to their CIS's such as the member's name, address, and logo; but in all cases, the use site precautions and the safe handling practices information will be separate, legible, and prominent.

The primary responsibility for ensuring that the CIS is disseminated to the consuming public will reside with the wood treaters. This voluntary program may be modified by EPA at a later date.

Inorganic Arsenical Pressure-Treated Wood

The following wording will appear on the Consumer Information Sheet (CIS) for inorganic arsenical pressure-treated wood:

Consumer Information - 'This wood has been preserved by pressure- treatment with an EPA-registered pesticide containing inorganic arsenic to protect it from insect attack and decay. Wood treated with inorganic arsenic should be used only where such protection is important.

Inorganic arsenic penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to inorganic arsenic may present certain hazards. Therefore, the following precautions should be taken both when handling the treated wood and in determining where to use or dispose of the treated wood'.

Use Site Precautions for Inorganic Arsenical Pressure-Treated Wood - 'Wood, pressure-treated with waterborne arsenical preservatives, may be used inside residences as long as all sawdust and construction debris are cleaned up and disposed of after construction.

Do not use treated wood under circumstances where the preservatives may become a component of food or animal feed. Examples of such sites would be structures or containers for storing silage or food.

Do not use treated wood for cutting-boards or countertops.

Only treated wood that is visibly clean and free of surface residue should be used in patios, decks and walkways.

Do not use treated wood for construction of those portions of beehives which may come into contact with the honey.

Treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges'.

Handling Precautions for Inorganic Arsenical Pressure-Treated Wood - 'Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g., construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with State and Federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.

When power-sawing and machining, wear goggles to protect eyes from flying particles.

After working with the wood, and before eating, drinking, and use of tobacco products, wash exposed areas thoroughly.

If preservatives or sawdust accumulate on clothes, launder before reuse. Wash work clothes separately from other household clothing'.

Creosote Pressure-Treated Wood

The following wording will appear on the Consumer Information Sheets (CIS) for creosote pressure-treated wood:

Consumer Information - 'This wood has been preserved by pressure treatment with an EPA-registered pesticide containing creosote to protect it from insect attack and decay. Wood treated with creosote should be used only where such protection is important.

Creosote penetrates deeply into and remains in the pressure- treated wood for a long time. Exposure to creosote may present certain hazards. Therefore the following precautions should be taken both when handling the treated wood and in determining where to use the treated wood'.

Use Site Precautions for Creosote Pressure-Treated Wood - 'Wood treated with creosote should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture) unless an effective sealer has been applied.

Creosote-treated wood should not be used in residential interiors. Creosote-treated wood in interiors of industrial buildings should be used only for industrial building components which are in ground contact and are subject to decay or insect infestation, and for wood block flooring. For such uses, two coats of an appropriate sealer must be applied. Sealers may be applied at the installation site.

Wood treated with creosote should not be used in the interiors of farm buildings where there may be in direct contact with domestic animals or livestock which may crib (bite) or lick the wood.

In interiors of farm buildings, where domestic animals or livestock are unlikely to crib (bite) or lick the wood, creosote-treated wood may be used for building components which are in ground contact and are subject to decay or insect infestation, if two coats of an effective sealer are applied. Sealers may be applied at the installation site.

Do not use creosote treated wood for farrowing or brooding facilities.

Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such use would be structures or containers for storing silage or food.

Do not use treated wood for cutting-boards or countertops.

Only treated wood that is visibly clean and free of surface residues should be used for patios, decks and walkways.

Do not use treated wood for construction of those portions

of beehives which may come into contact with the honey.

Creosote-treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

Do not use creosote-treated wood where it may come into direct or indirect contact with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges.

Handling Precautions for Creosote Pressure-Treated Wood - 'Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers, because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g., construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with State and Federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.

Avoid frequent or prolonged skin contact with creosote-treated wood. When handling the treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are vinyl-coated).

When power-sawing and machining, wear goggles to protect eyes from flying particles.

After working with the wood, and before eating, drinking, and use of tobacco products, wash exposed areas thoroughly.

If oil preservative or sawdust accumulate on clothes, launder before reuse. Wash work clothes separately from other household clothing.

Coal tar pitch and coal tar pitch emulsion are effective sealers for creosote-treated wood-block flooring. Urethane, epoxy and shellac are acceptable sealers for all creosote-treated wood'.

Pentachlorophenol Pressure-Treated Wood

The following wording will appear on the Consumer Information Sheets (CIS) for pentachlorophenol pressure-treated wood:

Consumer Information - 'This wood has been preserved by pressure- treatment with an EPA-registered pesticide containing pentachlorophenol to protect it from insect attack and decay. Wood treated with pentachlorophenol should be used only where such protection is important.

Pentachlorophenol penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to pentachlorophenol may present certain hazards. Therefore, the following precautions should be taken both when handling the treated wood and in determining where to use and dispose of the treated wood'.

Use Site Precautions for Pentachlorophenol Pressure-Treated Wood - 'Logs treated with pentachlorophenol should not be used for log homes.

Wood treated with pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied.

Pentachlorophenol-treated wood should not be used in residential, industrial, or commercial interiors except for laminated beams or building components which are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site.

Wood treated with pentachlorophenol should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock which may crib (bite) or lick the wood.

In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, pentachlorophenol-treated wood may be used for building components which are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site.

Do not use pentachlorophenol-treated wood for farrowing or brooding facilities.

Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be structures or containers for storing silage or food.

Do not use treated wood for cutting-boards or countertops.

Only treated wood that is visibly clean and free of surface residue should be used for patios, decks and walkways.

Do not use treated wood for construction of those portions of beehives which may come into contact with the honey.

Pentachlorophenol-treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

Do not use pentachlorophenol-treated wood where it may come into direct or indirect contact with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges'.

Handling Precautions for Pentachlorophenol Pressure-Treated Wood - 'Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g., construction sites) may be burned only in commercial or industrial incinerators or boilers rated at 20 million BTU/hour or greater heat input or its equivalent in accordance with State and Federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing or machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.

Avoid frequent or prolonged skin contact with pentachlorophenol- treated wood; when handling the treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are

vinyl-coated).

When power-sawing and machining, wear goggles to protect eyes from flying particles.

After working with the wood, and before eating, drinking and uses of tobacco products, wash exposed areas thoroughly.

If oily preservatives or sawdust accumulate on clothes, launder before reuse. Wash work clothes separately from other household clothing.

Urethane, shellac, latex epoxy enamel and varnish are acceptable sealers for pentachlorophenol-treated wood'.

PROTECTING THE ENVIRONMENT

Waste Disposal

Wastes from preservative treating operations can kill plant life and harm aquatic life if allowed to enter waterways. Oils and organic solids damage aquatic life by reducing oxygen supplies.

Some treating plants discharge their wastes into approved municipal sewer systems for processing along with municipal wastes. Many plants use closed chemical and wastewater recovery systems to contain wastes that could be harmful. Recovered solutions may be used again. If they are contaminated, they can be filtered to remove solid wastes. Liquid waste materials may be diverted to settling ponds (Fig. 28).

Figure 28
Settling pond.

Door sumps should be used under pressure-chamber doors and under hard-surfaced drainage areas. They will channel into the waste or recovery system any excess chemicals that drip or are rinsed from freshly treated material. It is also important to contain the runoff from areas where toxic chemicals are used to protect stored logs, poles, or lumber before processing or during seasoning.

The U.S. Environmental Protection Agency requires treatment facilities to meet certain disposal standards and to obtain permits for discharge of excess chemicals. Compliance with these regulations should assure proper environmental protection.

Remember to read the label carefully for disposal information for the products you are using.

Storage and Disposal of Containers

Packaged chemicals should be stored in a dry, well-ventilated, security locked area. Keep them in well-sealed containers whenever possible. Protect liquid storage against tank rupture (Fig. 29).

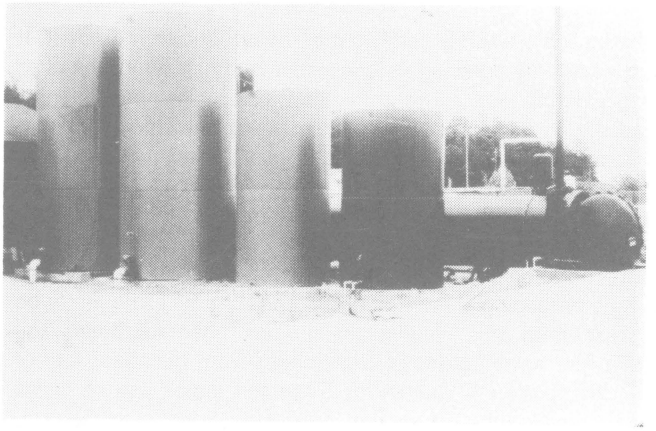

Figure 29
Storage tanks of preservatives.

Whenever spills, leaks, or flooding could occur, be sure that runoff will drain into a recovery or disposal system (Safeguard concrete vats from freezing, cracking and spillage).

Containers should be thoroughly rinsed and emptied into storage or treating tanks before disposal. Bury the containers in an approved landfill or dispose of them by other approved means. Be particularly careful not to contaminate streams or ground water.

Be sure to read and follow label requirements and safety-data sheets for each preservative. If you are in doubt about how to safely store a product or dispose of the empty containers, contact the supplier and follow his recommendations.

Spills

Correct cleanup procedures depend on the chemical involved. Treating-plant personnel should know what chemicals are being stored and used and should have an advance plan for handling spills. All workers who might be involved should know what help is available and who to notify in case of a major spill.

Environmental Exposure[1]

Penta

Penta is not uncommon in the aquatic environment. Circumstantial evidence, including the identification of penta in rain water, indicates that penta may occasionally be present in ambient air. Low levels of this compound have been detected in both wastewater and surface water. While the source of these residues is often unclear, it has been suggested that, in addition to direct contamination of water by penta, degradation of other organic compounds or chlorination of water may result in the chemical production of the compound.

1/ Adapted from: The Biologic and Economic Assessment of **Pentachlorophenol, Inorganic Arsenicals, Creosote.** Volume 1: Wood Preservatives. 1980. USDA. Cooperative Impact Assessment Report. Technical Bulletin 1658-1, 435 pp.

Penta is moderately persistent in the aquatic environment. It was reportedly detected in lake water and fish 6 months after an accidental spill. The prevailing use patterns of penta, primarily as a wood preservative, should preclude significant contamination of water as long as spills and industrial accidents are avoided.

Penta is moderately persistent in the soil. Published data report that persistence ranges from 21 days to 5 years. Under most conditions, penta will seldom persist in the soil for periods exceeding 9 months and its half-life will frequently be far less than this. Numerous studies have identified soil microorganisms capable of degrading penta, but the extent of their distribution is unknown. Since the major use of penta (wood preservative) does not involve application to the soil, the likeliest source of soil contamination is the leaching or bleeding of the preservative from treated wood. Such phenomena may result in low levels of penta contamination in the immediate vicinity (within several inches) of the treated wood.

Available data indicate that penta is not readily translocated by plants and that the compound in rapidly eliminated by mammals following exposure. Significant accumulation in plants and mammals is not likely to occur.

Arsenicals

No problems have been found in the literature as to the effects of arsenical wood preservatives on the environment. Arsenate, the form present in aerobic soils, is bound tightly to the soil components and becomes unavailable for plant uptake or leaching.

Creosote

There are no recorded reports of wild or domestic animals being injured by creosote.

The amount of creosote as a liquid that enters the environment is relatively small. The fate of creosote in the environment is not known, but most of its components are quickly biodegraded.

DEFINITIONS

Defined below are some of the terms used in this manual. Definitions were taken mainly from **Wood as an Engineering Material, Wood Handbook, USDA Agricultural Handbook No. 72, Revised 1974.**

Cellulose : The carbohydrate that is the principal constituent of wood and forms the framework of the wood cells.

Check : A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

Decay : The decomposition of wood substance by fungi. **Incipient decay**: The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.
Advanced (or typical) decay: The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent.

Dry Rot : A term loosely applied to any dry, crumbly rot, but especially to that which, when in an advanced stage, permits the wood to be crushed easily to a dry powder. The term is actually a misnomer for any decay, since all fungi require considerable moisture for growth.

Green : Freshly sawn or undried wood that still contains tree sap. Wood that has become completely wet after immersion in water would not be considered green, but may be said to be in the 'green condition'.

Hardwoods : Generally one of the botanical groups of trees that have broad leaves in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood.

Heartwood : The wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may contain phenolic compounds, gums, resins, and other materials that usually make it darker and more decay resistant than sapwood.

Kiln : A chamber having controlled air-flow, temperature, and relative humidity for drying lumber, veneer, and other wood products.

Lignin : The second most abundant constituent of wood, located principally in the secondary wall and the middle lamella, which is the thin cementing layer between wood cells. Chemically it is an irregular polymer of substituted propylphenol groups, and thus no simple chemical formula can be written for it.

Millwork : Planed and patterned lumber for finish work in buildings, including items such as sash, doors, cornices, panelwork, and other items of interior or exterior trim. Does not include flooring, ceiling, or siding.

Moisture Content : The amount of water contained in wood, usually expressed as a percentage of the weight of the ovendry wood.

Ovendry Wood : Wood dried to a relatively constant weight in a ventilated oven at 101 degrees to 105 degrees C.

Preservative : Any substance that, for a reasonable length of time, is effective in preventing the development and action of wood- rotting fungi, borers of various kinds, and harmful insects that deteriorate wood.

Sapwood : The wood of pale color near the outside of the log and just under the bark of a tree. Under most conditions the sapwood is more susceptible to decay than heartwood, and usually it is more receptive to impregnation with preservatives and fire retardants.

Seasoning : Removing moisture from green wood to improve its serviceability.
Air-dried: Dried by exposure to air in a yard or shed, without artificial heat.
Kiln Dried: Dried in a kiln with the use of artificial heat.

Soft Rot : A special type of decay developing under very wet conditions (as in cooling towers and boat timbers) in the outer wood layers, caused by cellulose-destroying microfungi that attack the secondary cell walls and not the intercellular layer.

Softwoods : Generally, one of the botanical groups of trees which, in most cases have needlelike or scalelike leaves; the conifers, also the wood produced by such trees. The term has no reference to the actual hardness of the wood.

Weathering : The mechanical or chemical disintegration and discoloration of the surface of wood caused by exposure to light, the action of dust and sand carried by winds, and the alternate shrinking and swelling of the surface fibers with the continual variation in temperature and moisture content brought by changes in the weather. Weathering does not include decay.

White-Rot : In wood, any decay or rot attacking both the cellulose and lignin and producing a generally whitish residue that may be spongy or stringy rot, or occur as pocket rot.

SOURCES OF INFORMATION

This manual is intended to provide basic information essential to safe handling of pesticides and to prepare treaters for certification. Changing of pesticide registration and use requires continuing study to keep up-to-date.

Proceedings, standards, and other publications of the American Wood Preservers Association provide current information of wood preservers. Other trade publications will also prove helpful.

Following are several references recommended for further study.

Handling Precautions for Penta and Santobrite. Technical Bulletin No. 0/PS-3, Monsanto Co., Organic Chemical Division, St. Louis, Missouri 63166.

Utilization of the Southern Pines. Peter Koch, USDA Agriculture Handbook No. 420, Aug. 1972. Provides information on wood- destroying organisms and the treating process.

Selection, Production, Procurement and Use of Preservative - Treated Wood, Supplementing Federal Specification TT-W-571. Lee R. Gjovik and Roy B. Baechler, USDA Forest Service, General Technical Report FPL-15, 1977.

Safe Handling Guide to Sapstain Control Chemicals, Western Wood Products Assoc., Portland, Oregon 1982. 14pp.

Preservative Treatment of Wood by Pressure Methods. J.D. Maclean, USDA Agriculture Handbook No. 40, Dec. 1952. Reprinted with corrections Sept. 1960.

Wood as an Engineering Material. Wood Handbook, Chapters 17-19, USDA Agriculture Handbook No. 72, Revised 1974.

Wood Deterioration and Its Prevention by Preservative Treatment. Darrel D. Nicholas, editor, with assistance of Wesley E. Loos, Syracuse University Press, 1973 (two volumes).

Wood Preservation. George M. Hunt and George A. Garratt, McGraw Hill Book Co., Inc., Third Edition, 1953.

The Analysis of Existing Wood Preserving Techniques and Possible Alternatives. B. Fuller et al. Metrek Division/The Mitre Corporation. Developed under contract with the U.S. Environmental Protection Agency, June, 1977.

Chlorophenate Wood Protection. British Columbia Ministry of Environment. 1983. D.E. Konasewich et al., Wood Protection Task Force, 90 pp.

The Preservation of Wood. Ian Stalker and Milton Applefield, Extension Entomology, University of Georgia,A correspondence course for wood treaters, 150 pp., 1986.

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